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Reproductive Parameters for Nine Avian Species at Moore Creek, Merritt Island National Wildlife Refuge

G. Tanner Girard
University of Central Florida, gtgirard@hotmail.com

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G. Tanner Girard, M.S.
Department of Biological Sciences
Florida Technological University
Orlando, Florida

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Introduction

Reproductive parameters for nine avian species were studied during the 1974-1975 breeding season at Moore Creek Rookery, Merritt Island National Wildlife Refuge, Brevard County, Florida. I observed nesting dates, nest construction and location, internest distance, clutch size, and mortality of eggs and young for Double-crested Cormorant (*Phalacrocorax auritus*), Anhinga (*Anhinga anhinga*), Great Blue Heron (*Ardea herodias*), Great Egret (*Casmerodius albus*), Snowy Egret (*Egretta thula*), Louisiana Heron (*Hydranassa tricolor*), Wood Stork (*Mycteria americana*), Glossy Ibis (*Plegadis falcinellus*), and White Ibis (*Eudocimus albus*). No study has previously been made of this rookery other than a few irregular censuses conducted by Refuge personnel. Furthermore, no other rookery of this size and composition has been studied on the east coast of Florida, yet land development continues to threaten both feeding and nesting habitats for these species. The rookery is located two miles from the National Aeronautics and Space Administration's (NASA) 15,000-foot runway designed for landing the Space Shuttle.

I observed 14 species of birds nesting in the rookery. Estimated numbers of nesting pairs follows: 200 Double-crested Cormorants; 50 Anhingas; 20 Great Blue Herons; 150 Great Egrets; 500 Snowy Egrets; 750 Cattle Egrets (*Bubulcus ibis*); 400 Louisiana Herons; 30 Little Blue Herons (*Florida caerula*); 5 Green Herons (*Butorides virescens*); 20 Black-crowned Night Herons (*Nycticorax nycticorax*); 100 Wood Storks; 60 Glossy Ibises; 1000 White Ibises; and 10 Boat-tailed Grackles (*Cassidix mexicanus*).

Most recent studies dealing with rookeries have focused on reproduction of Cattle Egrets (Lowe-McConnell 1967; Dusi and Dusi 1968, 1970; Jenni 1969, 1973; Siegfried 1971; Summerour 1971; and Weber 1975). Most other studies have focused on reproduction of one or two species in a rookery although Bowen *et al*. (1962) reported nesting success of four species in a rookery in southern Ghana, Teal (1965) studied five species at Sapelo Island, Georgia, and Jenni (1969) studied four species at Lake Alice, Florida. Reproductive parameters for the nine species that I studied have not previously been compared within a single rookery.

The Study Area

Moore Creek Rookery is within the Kennedy Space Center in an area administered by Merritt Island National Wildlife Refuge. The rookery is located on two islands near the mouth of Moore Creek impoundment (28° 35' N, 80° 42' W) and approximately 5 km west of the Vertical Assembly Building (VAB). I reached the rookery by driving 8 km on unpaved impoundment dikes to within 100 m of the islands. Although the rookery is easily accessed, it is not disturbed by human intrusion because of NASA's security restrictions. Brackish water, 1 to 2 m deep, surrounds the islands. Periodically the substrate of both islands was covered with water to a depth of 0.3 m.

The smaller island, designated as Island 1, was approximately 1.0 hectare in size and 100 m north of Island 2 (4.2 hectares). The dominant vegetation on both islands was white mangrove (Laguncularia racemosa). Heights of the mangroves ranged from 1.5 to 6.5 m.

Methods

The rookery was visited twice a week from 17 December 1974 to 29 May 1975. About 500 nests of the nine species were tagged and observations were completed on 440. Double-crested Cormorant, Anhinga, and approximately one-half of the Wood Stork nests were observed with a mirror attached at the end of a long pole. The eggs in these nests were not marked. For all other species, an indelible, felt-tip pen was used to mark eggs with the nest number and an additional numeral to distinguish eggs of the clutch. Nest heights were measured with a marked pole from the island substrate to the upper nest rim. Internest distance was measured with a tape from the nest rim to the rim of the nearest nest. Width and length of eggs were taken with calipers to the nearest 0.1 mm. Student's t-test was used to determine the significance between means; the significance level was 0.05, unless otherwise stated.

Results and Discussion

Nesting Dates

Great Blue Herons were the first to nest. On 17 December 1974, a nest containing four eggs was found; the young hatched during the first week of January. Assuming a four week incubation period (Bent 1926), the nest was probably constructed during the first week of December. All other Great Blue Heron nests were built in January and through the second week of February.

Double-crested Cormorants built nests on the north and northwest side of Island 2 during the latter part of December. Peak nest-building activity was attained by the second week of January. Cormorants then built nests on Island 1 and at various locations on Island 2, but in smaller numbers. They were still building nests or renesting in old nests when observations terminated on 29 May. At this time, four tagged nests held unhatched eggs and three had young less than two weeks old. Baynard (Sprunt 1954) found two cormorant nests with young in Mosquito Lagoon on 6 October 1929. This suggests that cormorants construct nests on Merritt Island for at least eight months of the year.

Wood Storks were first observed carrying nesting material on 1 February. The first eggs of this species were found on 1 March. On 4 February, I observed the first nesting activity by Anhingas. On that date some individuals were seen performing sexual displays, one pair was observed copulating, and several birds were constructing nests. Great Egrets and a few Snowy Egrets had established territories on Island 1 by 4 February. Nests with eggs of both species were found on 8 February. On 15 February, a few Louisiana Heron nests with eggs were found. The first White Ibis nest with one egg was found on 1 March and the first Glossy Ibis nest, which contained two eggs, was found on 29 March.

The only Green Heron nest found was built during the second week of February on Island 1. On Island 2 Little Blue Herons began nesting during the third week of March. On 29 March, a Boat-tailed Grackle nest with one egg was found. Cattle Egrets nested last. I saw the first individual carrying nesting material on 25 March. By 29 May many Cattle Egret nests held young, but most of their nests contained eggs. This species nested in the interior of Island 2 in areas where Snowy Egrets predominated.

Nesting dates were similar to those previously published except for the Snowy Egret, Louisiana Heron, and White Ibis which nested earlier than expected. The earliest reported nesting date for Snowy Egrets in Florida was 18 February 1959 at Greynold's Park, North Miami Beach (Palmer 1962). I found a nest containing one egg on 8 February. Palmer reported that Louisiana Herons in Florida began to lay in mid-March; at Moore Creek eggs were found on 15 February. I found the first White Ibis egg on 1 March, whereas Palmer reported nesting dates from late March (southern region of Florida) to April and May (central and northern regions). Unusually high daily temperatures during the latter part of January 1975 may have caused these birds to begin nesting early.

Nest Construction

Mangrove twigs gathered from the rookery's substrate, pulled from live trees, or pilfered from unattended nests were the basic nesting materials used by all species at Moore Creek. Double-crested Cormorant nests measured approximately 0.3 to 0.4 m in diameter. The platform of twigs was lined with stems of salt grass (Distichlis sp.) and occasionally mangrove leaves. Anhinga nests were about the same size as cormorant nests, but Anhinga nests had mangrove twigs with attached green leaves in the nest. Heron and egret nests were usually made of twigs. Great Blue Heron nests measured up to 1 m in diameter. Great Egrets built platforms from 0.5 to 0.6 m in diameter. Snowy Egret and Louisiana Heron nests were 0.2 to 0.4 m in diameter and built of slender twigs. Nests of Snowy Egrets and Louisiana Herons were very similar; unmarked, abandoned nests could not be distinguished.

Snowy Egrets and Louisiana Herons sometimes refurbished nests previously occupied by other birds. Two of 60 Snowy Egret nesting attempts were in nests originally built by Louisiana Herons. Snowy Egrets acquired these nests after the Louisiana Herons fledged. Three of 64 Louisiana Heron nesting attempts were in nests originally constructed by other species; two were made by Snowy Egrets and the third was built by White Ibises. In all three instances, Louisiana Heron eggs were laid in the nest one week after the disappearance of the original occupant's eggs or young.

Wood Stork nests were loose platforms of twigs approximately 1 m in diameter. During incubation and early young development, fresh mangrove leaves were brought to the nests. On several occasions I observed Wood Storks gather live mangrove twigs from the same location on the dikes.

Glossy Ibis nests were similar to those of Snowy Egret and Louisiana Heron. The nests measured 0.2 to 0.3 m in diameter and were made solely of twigs. The twigs, however, were usually thicker than those used by Snowy Egret, Louisiana Heron, or White Ibis. Ten of 23 Glossy Ibis nests were originally made by Snowy Egrets, Louisiana Herons, or White Ibises.

White Ibis nests measured 0.2 to 0.3 m in diameter. Unlike the other species, White Ibis nests had well-defined cups formed by a few sticks and lined with mangrove leaves. Occasionally, they placed other vegetation in the nest cup which included sea daisy (Borrichia frutescens), buttonwood (Conocarpus erecta), salt grass (Distichlis spicata), and Eupatorium serotinum. These plants were found on the impoundment dikes near the rookery.

Four of 87 White Ibis nesting attempts were in nests originally built by Louisiana Herons. In two nests, young Louisiana Herons successfully fledged before a pair of White Ibis acquired the structures. In one nest, White Ibis laid eggs one week after the Louisiana Heron eggs had disappeared. In the other nest, the Louisiana Heron eggs were replaced three days later by White Ibis eggs.

Nest Height and Location

Nest heights for all species are given in Table 1. Double-crested Cormorant nests were built significantly higher than those of all other species. Comparison of cormorant mean nest height with mean nest height for all other species gave t values greater than or equal to 5.07 ($p < 0.005$). Double-crested Cormorants nested at the top of mangroves in exposed positions which may be due to their labored flight takeoff. Cormorants nested on both islands although most individuals nested on Island 2.

Anhingas, Great Blue Herons, Great Egrets, Snowy Egrets, and Glossy Ibises nested on both islands. Great Blue Herons and Great Egrets nested primarily on Island 1, while Snowy Egrets and Glossy Ibises nested primarily on Island 2. Anhingas nested in the peripheral and interior areas. Great Blue Heron nests were scattered throughout Island 1, but the four tagged nests on Island 2 were all on the western edge. Great Egrets, Snowy Egrets, and Glossy Ibises nested in the interior on both islands. Although Great Egrets and Snowy Egrets nested at about the same height, they chose different nest sites; Great Egrets built in exposed positions while Snowy Egrets built in protected areas among mangrove branches.

TABLE 1

Nest Heights for Nine Avian Species

at Moore Creek, 1975

Species	Number	Range (m)	Mean ± S.D.
Double-crested Cormorant	83	2.8-6.1	4.72 ± 0.52
Anhinga	15	2.5-5.1	3.91 ± 0.80
Great Blue Heron	16	2.5-5.2	3.69 ± 0.82
Great Egret	59	1.2-2.4	1.68 ± 0.26
Snowy Egret	60	0.9-2.4	1.67 ± 0.33
Louisiana Heron	73	1.3-2.2	1.69 ± 0.23
Wood Stork	24	1.7-4.6	2.78 ± 0.87
Glossy Ibis	23	0.5-2.1	1.50 ± 0.44
White Ibis	87	1.0-2.7	1.78 ± 0.35

Glossy Ibis also nested in protected areas among the mangrove branches but their nests were placed significantly lower than all other species. Comparison of Glossy Ibis mean nest height with that for all other species gave t values greater than or equal to 2.02 ($p < 0.025$). This was the only species that nested at the base of mangroves.

Wood Storks nested only on Island 1. Louisiana Herons and White Ibises nested only on Island 2. Louisiana Heron nests were more concentrated at the southern end of the island than in the interior where Snowy Egrets predominated. No difference in height or placement exists between Louisiana Heron and Snowy Egret nests.

Mean nest height for the following three species which nested on both islands was significantly lower on Island 1 (Table 2): Double-crested Cormorant ($t = 4.17$; $p < 0.005$); Great Blue Heron ($t = 3.14$; $p < 0.005$); and Snowy Egret ($t = 5.06$; $p < 0.005$). The lower nesting heights for these species on Island 1 probably reflected the differences in the height of the mangroves.

Nest stratification at Moore Creek partially resembled the results reported by other investigators. On a small island in southern Ghana, the Long-tailed

TABLE 2

Nest Heights of Three Species Nesting on Islands 1 and 2 at Moore Creek, 1975

Species/Location	Number	Range (m)	Mean ± S.D.
Double-crested Cormorant			
Island 1	16	2.8-5.1	4.33 ± 0.76
Island 2	67	3.8-6.1	4.88 ± 0.38
Great Blue Heron			
Island 1	11	2.5-4.4	3.36 ± 0.66
Island 2	4	3.8-5.2	4.58 ± 0.68
Snowy Egret			
Island 1	26	0.9-2.4	1.45 ± 0.36
Island 2	40	1.4-2.3	1.81 ± 0.22

Shag (Phalacrocorax africanus) nested in the middle and upper branches whereas the African Darter (Anhinga rufa) nested around the peripheral areas (Bowen et al. 1962). At Moore Creek, Double-crested Cormorants nested higher than any other species; all nests were on the outer edge of both islands. Anhingas nested both around the periphery and in the interior at Moore Creek. In Arkansas, Meanley (1955) found that Great Egrets nested in the intermediate areas as they did at Moore Creek. Great Egrets nested higher than did Snowy Egrets in Arkansas (Meanley 1955) and on Little Marin Island in San Francisco Bay (Ralph and Ralph 1958). At Moore Creek, these species nested at the same height (Table 1). Palmer (1962) reported that in most instances Great Egrets nested comparatively high in large mixed colonies, but at Moore Creek, Great Egrets nested rather low. Meanley (1955) found Snowy Egrets to nest in the outermost bushes near the open water; at Moore Creek they occupied the interior of both islands. Jenni (1969) reported that Snowy Egrets and Louisiana Herons nested at the same height at Lake Alice, Florida, as they did at Moore Creek.

Internest Distance

Distance to nearest neighboring nest was measured for 314 nests (Table 3). Wood Storks nested closer to all nearest neighbors than did any other species. Only White Ibises lacked a mean internest distance significantly greater than that of Wood Storks ($t = 1.57$; $p < 0.10$). Great Egrets maintained the greatest internest distance. Comparison of mean distance to nearest neighboring nest for Great Egrets with that of other species gave t values greater than 2.42 ($p < 0.01$). Glossy Ibises and Louisiana Herons had essentially the same internest distance ($t = 0.41$; $p < 0.25$). Snowy Egrets nested significantly closer to all neighbors than did Louisiana Herons ($t = 2.25$; $p < 0.025$).

Table 4 gives mean internest distance for conspecific or other neighbors. Great Egrets had a significantly greater mean internest distance when a conspecific was nearest neighbor than when another species was nearest neighbor ($t = 1.86$; $p < 0.05$). Snowy Egret and Louisiana Heron internest distances were not different for conspecifics compared to other neighboring nesters. Glossy Ibis were widely dispersed through the rookery; only one of 21 nests had another Glossy Ibis as nearest neighbor. My

TABLE 3

Distance to Nearest Neighbor for Six Species, Moore Creek, 1975

Species	Nests	Range (m)	Mean ± S.D.
Great Egret	50	0.4-4.7	1.58 ± 0.92
Snowy Egret	65	0.4-5.3	0.91 ± 0.62
Louisiana Heron	74	0.4-2.6	1.13 ± 0.54
Wood Stork	20	0.3-0.9	0.48 ± 0.17
Glossy Ibis	21	0.3-2.0	1.06 ± 0.47
White Ibis	84	0.2-2.4	0.64 ± 0.45

TABLE 4

Conspecific and Interspecific Comparison of Internest Distance for Four Species, Moore Creek, 1975

Species	Neighbor	Number	Range (m)	Mean ± S.D.
Great Egret	same	32	0.7-3.5	1.78 ± 0.72
	others	18	0.4-4.7	1.29 ± 1.16
Snowy Egret	same	22	0.4-1.4	0.78 ± 0.36
	others	43	0.4-5.3	0.97 ± 0.75
Louisiana Heron	same	15	0.5-2.6	1.04 ± 0.65
	others	59	0.4-2.4	1.14 ± 0.51
White Ibis	same	65	0.2-2.4	0.54 ± 0.39
	others	19	0.4-2.0	0.99 ± 0.47

observation that Wood Storks and White Ibises were usually clumped nesters was confirmed by measuring internest distance. For 17 of 20 Wood Stork nests another Wood Stork was the nearest neighboring nester. White Ibis mean internest distance was significantly less when another White Ibis was nearest neighbor than when the nearest neighbor was another species ($t = 4.22$; $p < 0.005$).

Internest distances within rookeries have received little attention. In studies on Black-headed Gulls (*Larus ridibundus*) and Brewer's Blackbirds (*Euphagus cyanocephalus*), Kruuk (1964) and Horn (1968), respectively, discussed internest distance in relation to predation within colonies. Kruuk observed that if predators are attacked by owners of a nest at a distance greater than the average internest distance, then there will be more potential defenders within a colony than at the edge. At Moore Creek I found no evidence of mammalian predation. However, avian predation was greatest for Wood Storks and White Ibises. Most Wood Stork nests (85%) had another Wood Stork nest as nearest neighbor. White Ibises had significantly smaller mean internest distance when a conspecific was nearest neighbor ($t = 4.22$; $p < 0.005$; Table 4). Clumping of Wood Stork and

White Ibis nests might be a defense mechanism against avian predators. Bent (1926) reported that Fish Crows (Corvus ossifragus) observed at Bird Key, Florida, stole more eggs from White Ibises than from herons since the soft bill of the White Ibis was not a formidable defense weapon as was the sharp heron's bill.

Clutch Size

Tables 5 and 6 give the clutch size and frequency of the clutch size for all nesting attempts that hatched young. In most instances, clutch size agreed with published reports.

Double-crested Cormorants laid from two to four eggs in 74 nesting attempts (mean 3.2). Bent (1922) reported three eggs per clutch, sometimes two, and rarely four. At Moore Creek clutches of four were not rare (Table 6). Sprunt (1954) reported three or four eggs as the usual clutch. De La Ronde and Greichus (1972) gave the mean clutch size as 3.2 eggs in 55 nests studied at Dry Lake Rookery, South Dakota. No significant difference exists between early and late cormorant clutches. There was only one peak of egg-laying; 60.8% of all cormorant nests held young between 4 and 8 February.

TABLE 5

Clutch Size of Nine Avian Species for Nesting Attempts Hatching Young, Moore Creek, 1975

Species	Number	Clutch Size	Mean ± S.D.
Double-crested Cormorant	74	2-4	3.2 ± 0.62
Anhinga	11	3-5	4.1 ± 0.54
Great Blue Heron	12	2-4	3.0 ± 0.17
Great Egret	45	1-4	2.4 ± 0.62
Snowy Egret	60	2-4	3.0 ± 0.56
Louisiana Heron	64	2-4	3.0 ± 0.50
Wood Stork	16	2-4	2.9 ± 0.44
Glossy Ibis	9	1-3	2.4 ± 0.73
White Ibis	77	1-3	2.4 ± 0.57

TABLE 6

Frequency of Clutch Size for Nesting Attempts Hatching Young at Moore Creek, 1975

Species	Clutch Size 1	2	3	4	5
Double-crested Cormorant		7	45	22	
Anhinga			1	8	2
Great Blue Heron		2	8	2	
Great Egret	2	22	20	1	
Snowy Egret		3	41	11	
Louisiana Heron		8	48	8	
Wood Stork		2	13	1	
Glossy Ibis	1	3	5		
White Ibis	3	40	34[a]		

[a]Egg laid in one nest 1.5 weeks before hatching not counted as fourth member of clutch.

Anhingas laid from three to five eggs in 11 nesting attempts (mean 4.1). These data differ from those cited by Bent (1922); he gave the usual clutch size as three eggs. Howell (Sprunt 1954) reported from three to six eggs per clutch. From 29 nests, Meanley (1954) gave the clutch size as two to five eggs (mean 3.8) at Swan Lake, Arkansas.

Great Blue Herons laid from two to four eggs in 12 nesting attempts (mean 3.0). Bent (1926) stated that this species most commonly laid four eggs. From 347 clutches in the Philadelphia region, Miller (Palmer 1962) gave the average as 4.37 eggs. Nicholson (Sprunt 1954) reported clutches of three or four eggs in a rookery in central Florida.

Great Egrets laid from one to four eggs in 45 nesting attempts (mean 2.4). Bent (1926) gave the clutch size for this species as three or four eggs. Howell (Sprunt 1954) reported four eggs as the usual number. At Avery Island, Louisiana, clutch size ranged from one to four eggs in 48 nests with a mean of 3.2 (Simmons 1959). Teal (1965) found clutches of two, three, and five eggs from 30 nests (mean 3.1) at Sapelo Island, Georgia.

Great Egrets, Snowy Egrets, and Louisiana Herons had two egg-laying periods (Table 7). Twenty-two

TABLE 7

Comparison of Early and Late Clutches of Three Species at Moore Creek, 1975

Species/Hatching Dates	Number	Clutch Size	Mean ± S.D.
Great Egret			
3 Mar-22 Mar	22	1-4	2.8 ± 0.61
25 Mar-22 Apr	23	1-3	2.2 ± 0.51
Snowy Egret			
8 Mar- 8 Apr	49	2-4	3.1 ± 0.52
22 Apr- 6 May	11	2-4	2.7 ± 0.65
Louisiana Heron			
11 Mar- 5 Apr	49	2-4	3.1 ± 0.44
15 Apr-10 May	15	2-3	2.6 ± 0.51

Great Egret nesting attempts produced young between 8 and 22 March whereas twenty-three nests hatched young between 25 March and 22 April. Mean clutch sizes for the first and second peak periods were 2.8 and 2.2 respectively. These means are significantly different ($t = 2.89$; $p < 0.005$).

Snowy Egrets laid from two to four eggs in 60 nesting attempts (mean 3.0). My data differ from Bent's (1926) statement that Snowy Egrets laid four or five eggs, sometimes three, and rarely six. Howell (Sprunt 1954) gave three or four eggs per clutch. Teal (1965) in Georgia and Jenni (1969) at Lake Alice, Florida observed clutches of two to five eggs with means of 3.2 (29 nests) and 3.9 (102 nests), respectively.

Means for early and late clutches of Snowy Egrets were significantly different ($t = 2.15$; $p < 0.025$; Table 7). Nesting attempts hatching young between 8 March and 8 April contained from two to four eggs (mean 3.1). Attempts hatching young between 22 April and 6 May had from two to four eggs (mean 2.7). Jenni (1969) also reported a decrease in Snowy Egret clutch size late in the nesting season at Lake Alice, Florida.

Louisiana Herons laid from two to four eggs in

65 nesting attempts (mean 3.0). Bent (1926) cited clutch size as being four or five eggs, sometimes three, occasionally six, and rarely seven. Howell (Sprunt 1954) reported clutches of three to five eggs. Teal (1965) observed clutches of two to four eggs (mean 3.1) in 15 nests studied at Sapelo Island, Georgia. Jenni (1969) found clutches of three to six eggs in 36 nests (mean 4.1) at Lake Alice, Florida.

Means for early and late clutches of Louisiana Herons were significantly different ($t = 3.89$; $p < 0.005$; Table 7). Nesting attempts hatching young between 11 March and 5 April produced two to four eggs (mean 3.1). Nesting attempts hatching young between 15 April and 10 May produced two or three eggs (mean 2.6).

Wood Storks laid from two to four eggs in 16 nesting attempts (mean 2.9). Bent (1926) described clutch size as three, sometimes four, and rarely five eggs. Howell (Sprunt 1954) reported the usual clutch as two or three eggs. Kahl (1964) gave the clutch size range in Wood Storks as two to five eggs. In 1960, he observed an average of 3.3 eggs per nest (13 nests) in the Panther Point colony, Polk County, Florida.

Glossy Ibises laid from one to three eggs in nine nesting attempts (mean 2.4). An untagged nest had four eggs. Baynard (1913), Bent (1926), and Sprunt (1954) gave clutches of three or four eggs for this species.

White Ibis laid from one to three eggs in 77 nesting attempts (mean 2.4). My observations differed from those of Bent (1926) who reported that White Ibis laid four and sometimes three or two, but rarely five eggs. Sprunt (1954) gave three or four eggs as the clutch size. Teal (1965) observed two or three eggs per clutch in 14 nests studied at Sapelo Island, Georgia (mean 2.6).

Egg Measurements

Egg lengths and widths for seven species were measured (Table 8). The measurements are similar to those reported by Bent (1926) with two exceptions. One Great Blue Heron nest held an abnormally small egg (43.4 X 36.6 mm) in addition to two normal eggs. The nest and all three eggs disappeared before the next observation. This small egg was about the same size as a normal Snowy Egret or Louisiana Heron egg. Dumping of eggs in other nests has been discussed by Jenni (1969) and observed by Dusi and Dusi (1970) in a rookery in Dothan, Alabama. Because the egg

TABLE 3

Egg Measurements for Seven Species at Moore Creek, 1975

Species	Number	Range (mm)	Mean
Great Blue Heron	11	71.3-62.6 X 48.8-45.2	66.40 X 46.65
Great Egret	32	63.7-44.3 X 49.5-38.4	54.60 X 40.55
Snowy Egret	53	45.4-32.8 X 40.9-23.0	42.28 X 31.98
Louisiana Heron	28	49.7-41.2 X 35.1-30.3	45.44 X 32.72
Wood Stork	5	70.0-67.4 X 50.9-47.4	69.02 X 48.96
Glossy Ibis	20	55.0-49.4 X 38.8-33.4	52.02 X 35.84
White Ibis	102	63.4-48.3 X 46.0-31.4	57.88 X 38.82

color for these three species is similar, the origin of this small egg is unknown.

One small egg (49.7 X 31.6 mm) was laid in a Wood Stork nest containing two normal eggs. This egg was smaller than the minimum measurements given by Bent (1926) and fits Rothstein's (1973) definition of a runt egg. Rothstein believes that runt eggs are extremely rare in birds. The runt egg and the two others disappeared.

Egg Mortality

Nesting attempts observed and total eggs laid by nine species are given in Table 9. Egg mortality is given for all nesting attempts in Table 10 and for nesting attempts hatching young in Table 11. Egg mortality, as a percentage of total eggs laid, was greater for nesting attempts failing to hatch young than losses from nesting attempts hatching young (Table 10).

Several authors have reported egg loss due to faulty nest construction (Teal 1965; Jenni 1969; Dusi and Dusi 1970). This factor was probably a minor one at Moore Creek since nests were generally well-built and well supported by the mangroves. Twig pilfering by other nesters probably caused some egg

TABLE 9

Number of Nesting Attempts and Eggs Observed for Nine Species at Moore Creek, 1975

Species	Nests	Nesting Attempts	Eggs Laid
Double-crested Cormorant	83	90	285
Anhinga	15	21	69
Great Blue Heron	16	16	46
Great Egret	59	67	152
Snowy Egret	66	67	201
Louisiana Heron	73	80	236
Wood Stork	24	24	88
Glossy Ibis	23	24	54
White Ibis	87	104	251

TABLE 10

Total Egg Loss for Nine Species at Moore Creek, 1975

Species	Egg Loss as Percent of Total Eggs Laid		
	Nests Without Hatched Young	Nests With Hatched Young	Total
Double-crested Cormorant	16.8	17.2	34.0
Anhinga	34.8	10.1	44.9
Great Blue Heron	21.8	13.0	34.8
Great Egret	27.6	4.6	32.2
Snowy Egret	8.9	6.0	14.9
Louisiana Heron	18.6	4.8	23.4
Wood Stork	46.6	13.6	60.2
Glossy Ibis	59.2	5.6	64.8
White Ibis	25.9	8.8	34.7

TABLE 11

Egg Mortality in Nesting Attempts Hatching Young at Moore Creek, 1975

Species	Egg Loss as Percent of Total Eggs Laid in Nesting Attempts Hatching Young			
	Disappeared During Incubation	Unexplained Hatching Loss[a]	Failed to Hatch	Total
Double-crested Cormorant	3.4	7.3	9.9	20.6
Anhinga	6.7	8.9	0	15.6
Great Blue Heron	2.7	11.1	2.8	16.6
Great Egret	0.9	0.9	4.5	6.3
Snowy Egret	1.1	4.9	0.5	6.5
Louisiana Heron	1.6	3.1	1.0	5.7
Wood Stork	4.2	19.1	2.2	25.5
Glossy Ibis	0	13.6	0	13.6
White Ibis	2.2	5.9	3.8	11.9

[a]Loss in this category occurred in the two or three days preceding my first observation of young in the nest.

loss. In Arkansas, Meanley (1955) witnessed several instances of egg loss in unguarded nests due to pilfering of nesting material. Kushlan (1973) observed an unprotected White Ibis nest containing one egg dismantled by adjacent White Ibis. At Moore Creek abandoned nests were usually pilfered.

Avian predation was the most important factor of egg mortality whereas mammalian predation was minimal. Although Otter (Lutra canadensis) tracks were seen on one occasion at the edge of Island 1, no other mammal sign was found. Many eggshells containing holes were found. Fish Crows and Boat-tailed Grackles were seen regularly and could have been possible predators. Both species have been reported as egg predators in other rookeries (Bent 1926; Jenni 1969). Turkey Vultures (Cathartes aura) were occasionally seen at Moore Creek, but probably were after dead young. I believe that Wood Storks had the greatest egg loss due to avian predation. Many empty eggs containing holes were found below the nest. Some White Ibis eggs and a few eggs of other species were also found with holes.

In 8 of 24 Wood Stork nesting attempts some of the eggs disappeared before the clutch was completed. For example, in nest #314 a clutch was never completed.

One egg found on 4 March disappeared on 8 March. Another egg found on 15 March, had disappeared by 19 March. Two eggs were found on 1 April; they were gone by 5 April. One egg found on 12 April disappeared on 15 April. In 24 Wood Stork nesting attempts 46.6% of their eggs laid was lost in nesting attempts failing to hatch young.

Glossy Ibis had the highest egg loss of any species failing to hatch young; only 9 of 23 nesting attempts hatched young (Table 10). In recent years numbers of Glossy Ibis in the central Florida area have declined. This decline may be a result of habitat destruction through drainage in the upper St. Johns River marshes (Sprunt 1954). This area is approximately 12 miles west of Moore Creek. The relatively high Glossy Ibis egg loss suggests that a more detailed study of its reproductive biology is needed to ascertain factors which limit Glossy Ibis numbers. Since most Glossy Ibis eggs disappeared, the exact toll of avian predation could not be determined. Interaction with other nesters could be a factor for their reduced reproductive success. Glossy Ibis nested late when most other nesters were feeding young. Scarcity of potential nesting sites was indicated by the following observations:

10 of 23 Glossy Ibis nests were originally built by other birds; Glossy Ibis were the only birds nesting at the base of mangroves; and their nests were dispersed through the rookery.

In nesting attempts successful in hatching young, the greatest egg loss was from unknown egg mortality associated with hatching. For all species, few eggs disappeared during incubation from the clutches which produced young. The percentage of eggs lost during incubation ranged from 0% for Glossy Ibises to 6.7% for Anhingas (Table 11). Some eggs did not hatch. In several Double-crested Cormorant nests an egg remained in the nest for weeks after the other eggs had hatched. Egg loss from failure to hatch ranged from 0% for Glossy Ibises to 9.9% for Double-crested Cormorants (Table 11). Much unexplained egg mortality associated with hatching occurred in the two or three days preceding my first observation of young in the nest. For example, I would observe three eggs in a nest and three days later there would be one egg and one young. Loss in this category ranged from 0.9% for Great Egrets to 19.1% for Wood Storks (Table 11). Jenni (1969) also observed greater egg losses on the day before through hatching than losses during preceding incubation at Lake Alice, Florida.

There are some reports of egg mortality in the literature for comparison. Bowen et al. (1962) observed 20% egg mortality for the Long-tailed Shag in Ghana. At Moore Creek, Double-crested Cormorant egg mortality was 34.0% (Table 10). Bowen et al.(1962) reported 11% egg mortality for first broods and 42% egg mortality for second broods of the African Darter. Anhinga egg mortality was 44.9% at Moore Creek (Table 10).

At Sapelo Island, Georgia, Teal (1965) observed egg mortality for four avian species which I studied at Moore Creek. For the four, Teal (1965) found greater egg mortality than I observed (Table 10). Comparative egg mortality follows: 47% for Great Egrets at Sapelo Island and 32.2% at Moore Creek; 35% for Snowy Egrets at Sapelo Island and 14.9% at Moore Creek; 27% for Louisiana Herons at Sapelo Island and 23.4% at Moore Creek; and 61% for White Ibises at Sapelo Island and 34.7% at Moore Creek. Teal (1965) observed egg loss from mammalian predators such as raccoons (*Procyon lotor*) which evidently were not present on the islands even though they are abundant on Merritt Island.

Jenni (1969) reported higher egg mortality for Snowy Egrets and Louisiana Herons at Lake Alice, Florida, than I found at Moore Creek. Snowy Egret egg loss at Lake Alice was 6.2% during incubation and 1.1% at Moore Creek (Table 11). Louisiana Herons lost 3.9% of their eggs during incubation at Lake Alice and 1.6% at Moore Creek. Higher egg mortality at Lake Alice suggests that there was more egg predation than at Moore Creek. Also, lower egg loss at Moore Creek than at Lake Alice may be partially due to the more isolated location of the Moore Creek rookery.

Mortality of Young

Mortality of young is summarized in Table 12. Double-crested Cormorant nestling mortality was observed through six weeks. Nestlings stayed close to the nest, even at late ages. This is probably due to the clumsiness in perching because of their webbed feet. They fledged at approximately six and a half to eight weeks. Greatest mortality of cormorant nestlings was during the two weeks following hatching (Table 12). Nestlings died in the nests, probably from starvation, and many apparently well fed young fell from nests. On two occasions I observed a nestling knocked from the nest as a startled adult flew off.

TABLE 12

Mortality of Young of Nine Species,

Moore Creek, 1975

Species	Percent Mortality Biweekly 0-2	2-4	4-6	6-8	Total
Double-crested Cormorant (74 nests)	35.6	18.7	7.4	...	61.7
Anhinga (11 nests)	7.9	15.8	...	...	23.7
Great Blue Heron (12 nests)	33.3	23.4	3.2	0	59.9
Great Egret (45 nests)	16.5	21.4	...	...	37.9
Snowy Egret (60 nests)	15.8	...	...	...	15.8
Louisiana Heron (64 nests)	28.2	...	...	...	28.2
Wood Stork (16 nests)	25.5	0	...	...	25.5
Glossy Ibis (9 nests)	42.1	...	...	...	42.1
White Ibis (77 nests)	40.2	...	...	...	40.2

Great Blue Herons were the only birds observed until all young had fledged. Of 30 young hatched, 20 survived for two weeks, 13 survived four weeks, and 12 survived at six and eight weeks. The 12 fledged between 8.5 and 12.5 weeks; average age at fledging was 9.5 weeks. All young Great Blue Herons had fledged by the middle of May. Starvation was the most probable cause of Great Blue Heron nestling death. In all cases the smallest of the brood died first. Dead young were found on the ground below the nest, or enmeshed in the sides or cup of the nest.

An indication exists that Great Blue Herons were more unsuccessful if their nests were near roost and nest sites of Wood Storks. Six unsuccessful Great Blue Heron nests were in close proximity to nesting Wood Storks. These nests represented three-fourths of the Great Blue Heron nesting failures. Wood Storks laid eggs in one of the nests shortly after I found the dead heron nestling below the structure.

Anhinga, Great Egret, and Wood Stork nestling mortality was observed for four weeks. Anhingas had less nestling mortality during the first two weeks than during the second two weeks. Great Egret nestling mortality was greatest during the first two weeks. For Wood Storks, all nestling mortality occurred during the first two weeks after hatching.

Nestling mortality for Snowy Egrets, Louisiana Herons, Glossy Ibises, and White Ibises was studied for two weeks. Of these species, Snowy Egrets had the lowest nestling mortality (Table 12). When young of the smaller ciconiids reached two weeks of age, they began to climb from the nest; it was not uncommon to find some entangled in the branches. These young died either from injuries or from starvation.

Comparison of nestling mortality at Moore Creek with published reports from other rookeries is possible for only a few species. Generally, nestling mortality was lower at Moore Creek than in other rookeries. Snowy Egrets had a lower nestling mortality at two weeks (15.8%) at Moore Creek than Teal (1965) observed at Sapelo Island, Georgia (62%), and Jenni (1969) reported at Lake Alice, Florida (28.1%). Louisiana Heron nestling mortality was 57% at Sapelo Island. This is much higher than 28.2% found at Moore Creek. However, Jenni (1969) found slightly lower Louisiana Heron nestling mortality (25.4%) than I observed at Moore Creek. Teal (1965) reported lower White Ibis nestling mortality (28%) at Sapelo Island than I found at Moore Creek (40.2%).

Mortality figures for species closely related to the birds nesting at Moore Creek are available from the literature. Bowen et al. (1962) reported 27% nestling mortality for the Long-tailed Shag, and 28% for African Darter first broods and 60% for second broods. Mortality of nestling Great White Herons was about 40% (Palmer 1962). Owen (1960) reported that nestling mortality of Gray Herons (Ardea cinerea) in England varied from two to 46% for three rookeries over several years. He excluded losses due to predators in his calculations. Bowen et al. (1962) observed 54% Cattle Egret nestling mortality in Ghana. Jenni (1969) found 8.2% Cattle Egret nestling mortality through two weeks at Lake Alice, Florida. At Cliftonville, Mississippi, Summerour (1971) observed 29.8% Cattle Egret mortality for two weeks. In Arkansas, Meanley (1955) reported mortality of Little Blue Heron nestlings as 18.8% through two weeks, in Florida Jenni (1969) found 37.7%, and in Mississippi Summerour (1971) reported 6.6%.

Tables 13 and 14 show young surviving per nest at specified intervals. Young per nest is given as both actual number per nest and young per nest hatching young; this accounts for complete failure of nests hatching young.

Double-crested Cormorants and Great Blue Herons

TABLE 13

Young Surviving Per Nest for Five Species, Moore Creek, 1975

Young	Double-crested Cormorant	Anhinga	Great Blue Heron	Great Egret	Wood Stork
Hatching					
young/nest	2.5	3.4	2.5	2.3	2.2
2 weeks					
young/nest	2.0	3.2	1.8	2.1	1.9
young/nest hatching young	1.6	3.2	1.7	1.9	1.4
4 weeks					
young/nest	1.8	2.9	1.6	1.6	1.9
young/nest hatching young	1.2	2.6	1.1	1.4	1.4
6 weeks					
young/nest	1.6	...	1.5	...	...
young/nest hatching young	1.0	...	1.0	...	...
8 weeks					
young/nest	...	...	1.5	...	...
young/nest hatching young	...	...	1.0	...	...

TABLE 14

Young Surviving Per Nest for Four Species, Moore Creek, 1975

Young	Snowy Egret	Louisiana Heron	Glossy Ibis	White Ibis
Hatching				
young/nest	2.8	2.8	2.1	2.1
2 weeks				
young/nest	2.5	2.3	1.6	1.5
young/nest hatching young	2.3	2.0	1.2	1.3

had similar survival rates (Table 13). For both species, heaviest mortality occurred during the first two weeks after hatching.

Anhingas hatched 3.4 young per nest, the highest recorded at Moore Creek (Table 13). Anhingas lost only 0.8 young per nest in four weeks. Double-crested Cormorants and Great Blue Herons lost 1.3 and 1.4 young per nest for the same period.

Great Egrets and Wood Storks hatched about the same number of young. For both species, 1.4 young survived per nest hatching young at four weeks. The first two weeks of Wood Stork nestling life was more critical; Great Egrets suffered nestling mortality over the four week period while Wood Storks experienced nestling mortality only during the first two weeks.

Snowy Egrets and Louisiana Herons hatched the same number of young per nest, but at two weeks Snowy Egret broods were larger (Table 14). However, the difference in mean brood size at two weeks is not significant ($t = 1.58$; $p < 0.10$). At Lake Alice, Florida, Jenni (1969) found that Louisiana Herons had larger broods at hatching and at two weeks than Snowy Egrets. Louisiana Herons hatched 3.7 young per nest (29 nests) and 2.8 young survived for two weeks. Snowy Egrets hatched 3.3 young per nest

(91 nests) and 2.2 young survived for two weeks.

Glossy Ibis and White Ibis hatched broods of 2.1 young (Table 14). At two weeks, 1.2 Glossy Ibis nestlings survived per nest hatching young and 1.3 White Ibis nestlings survived.

Variation in Clutch Size

Mean clutch size of many birds increases with increasing distance from the equator (Lack 1954; Ricklefs 1970; and von Haartman 1971). Mean clutch sizes for three species studied at Moore Creek have been sufficiently reported in the literature for comparison with this trend. Great Egret mean clutch size seems to increase with increasing latitude; mean clutch size was 2.4 eggs at Moore Creek, 3.1 at Sapelo Island, Georgia (Teal 1965), and 3.2 at Avery Island, Louisiana (Simmons 1959). However, this trend is not evident for Snowy Egret and Louisiana Heron clutches. Mean clutch size for Snowy Egrets was 3.0 at Moore Creek, 3.9 at Lake Alice, Florida (Jenni 1969), and 3.2 at Sapelo Island, Georgia (Teal 1965). Louisiana Heron mean clutch size was 3.0 at Moore Creek, 4.1 at Lake Alice, and 3.1 at Sapelo Island.

According to Lack's (1954) "food-limited" hypothesis, clutch size is adapted to producing the greatest number of young which the adults can successfully feed. Lack proposed that more daylight hours at greater latitudes during the breeding season increased the foraging time of the adults. They should be able to successfully feed larger broods, resulting in larger mean clutch size with increased distance from the equator. Seasonal variation in clutch size at Moore Creek does not support Lack's "increased daylight" explanation for increased clutch sizes with increasing latitude. Clutch sizes of Great Egrets, Snowy Egrets, and Louisiana Herons became significantly smaller (Table 7) before the summer solstice with its maximum daylight hours. In addition, von Haartman (1971) has documented several examples where broods are maximal before midsummer. Another difficulty with Lack's proposal is that nocturnal birds do not reverse the trend displayed by diurnal birds but have a reduced clutch size nearer to the equator (von Haartman 1971).

Relative food availability may be indicated by comparing clutch size to young produced per nest. Species nesting at Moore Creek hatched asynchronously. Lack (1954, 1966) interprets asynchronous hatching as a mechanism which allows for the greatest number of young to be produced in years of food abundance. Yet, during years when less food is available the number is adjusted by starvation of the youngest. If food were abundant, larger clutches should produce more young. On the other hand, if food were less available, smaller clutches should produce as many young as larger clutches.

Using these criteria, Double-crested Cormorants and Great Egrets did not find food plentiful (Tables 15 and 16). Generally, larger clutches produced the same number of young as smaller clutches. Although cormorant clutches of two produced significantly less young per nest hatching young at six weeks than clutches of three or four ($t = 4.37$, $p < 0.005$; $t = 3.20$, $p < 0.005$, respectively), clutches of three and four produced about the same young per nest hatching young ($t = 0.04$). Great Egret clutches of three produced 1.5 young per nest hatching young at four weeks and clutches of two produced 1.4 young ($t = 0.04$). Great Egret clutches of one egg (2 nests) and four eggs (1 nest) were too few for statistical comparison.

Snowy Egrets (Table 17), Louisiana Herons (Table 18), and White Ibis (Table 19) found abundant

TABLE 15

Double-crested Cormorant Young Surviving Per Nest for Different Clutch Sizes, Moore Creek, 1975

Young	Clutch Size		
	2 (7 nests)	3 (45 nests)	4 (22 nests)
Hatching			
percent eggs hatched	92.8	80.7	75.0
young/nest	1.9	2.4	3.0
2 weeks			
percent young hatched	61.5	67.9	65.2
young/nest	1.6	1.9	2.4
young/nest hatching young	1.1	1.6	2.0
4 weeks			
percent young hatched	38.5	50.4	33.3
young/nest	1.2	1.8	1.8
young/nest hatching young	0.7	1.2	1.2
6 weeks			
percent young hatched	30.8	39.4	37.9
young/nest	1.3	1.5	1.9
young/nest hatching young	0.3	1.0	1.1

TABLE 16

Great Egret Young Surviving Per Nest for Different Clutch Sizes, Moore Creek, 1975

Young	Clutch Size 1 (2 nests)	2 (22 nests)	3 (20 nests)	4 (1 nest)
Hatching				
percent eggs hatched	100	97.7	90.0	100
young/nest	1.0	2.0	2.7	4.0
2 weeks				
percent young hatched	100	86.0	81.5	75.0
young/nest	1.0	1.8	2.4	3.0
young/nest hatching young	1.0	1.7	2.1	3.0
4 weeks				
percent young hatched	100	83.8	68.2	33.3
young/nest	1.0	1.6	1.8	1.0
young/nest hatching young	1.0	1.4	1.5	1.0

TABLE 17

Snowy Egret Young Surviving Per Nest for Different Clutch Sizes, Moore Creek, 1975

Young	Clutch Size 2 (8 nests)	Clutch Size 3 (41 nests)	Clutch Size 4 (11 nests)
Hatching			
percent eggs hatched	94.8	94.3	90.9
young/nest	1.9	2.8	3.6
2 weeks			
percent young hatched	86.7	78.4	85.0
young/nest	1.9	2.5	3.1
young/nest hatching young	1.6	2.2	3.1

TABLE 18

Louisiana Heron Young Surviving Per Nest for Different Clutch Sizes, Moore Creek, 1975

Young	Clutch Size 2 (8 nests)	Clutch Size 3 (48 nests)	Clutch Size 4 (8 nests)
Hatching			
percent eggs hatched	93.8	93.8	96.9
young/nest	1.9	2.8	3.9
2 weeks			
percent young hatched	73.3	73.3	64.5
young/nest	1.8	2.2	2.9
young/nest hatching young	1.4	2.1	2.5

TABLE 19

White Ibis Young Surviving Per Nest for Different Clutch Sizes, Moore Creek, 1975

Young	Clutch Size		
	1 (3 nests)	2 (40 nests)	3 (34 nests)
Hatching			
percent eggs hatched	100	87.5	89.2
young/nest	1.0	1.8	2.7
2 weeks			
percent young hatched	66.7	77.5	57.1
young/nest	1.0	1.3	1.8
young/nest hatching young	0.7	1.0	1.6

food; larger clutches produced more young at two weeks than smaller clutches. Snowy Egret clutches of four produced 3.1 young at two weeks compared to 2.2 young from clutches of three ($t = 3.06$; $p < 0.005$) which was greater than 1.6 young produced by clutches of two ($t = 1.67$; $p < 0.05$). Louisiana Heron clutches of four produced 2.5 young at two weeks compared to 2.1 young from clutches of three ($t = 1.90$; $p < 0.05$) which was greater than 1.4 young produced by clutches of two ($t = 1.67$; $p < 0.05$). White Ibis clutches of three produced 1.6 young at two weeks compared to 1.0 young from clutches of two ($t = 3.57$; $p < 0.005$) which appeared greater than 0.7 young produced by clutches of one ($t = 0.74$; $p < 0.25$). All comparisons were significant at the 0.05 level except in the case of White Ibis clutches of one egg; the small number of nesting attempts (3) probably contributed to a small t value when production of young was compared with that of White Ibis two egg clutches.

Summary

Reproductive parameters for nine avian species were studied at Moore Creek Rookery during the 1974-1975 breeding season. The rookery is on two white mangrove islands in the Merritt Island National Wildlife Refuge, Florida. Great Blue Herons were the first to breed followed by Double-crested Cormorants, Anhingas, Great Egrets, Snowy Egrets, Louisiana Herons, Wood Storks, White Ibises, and Glossy Ibises. Nest construction for all species was similar to descriptions previously published.

Generally, nests were stratified by height. Double-crested Cormorants nested higher than all other species while Glossy Ibises built the lowest nests. Great Egrets nested relatively low which is unusual, compared to other published accounts. Snowy Egrets, Louisiana Herons, and White Ibises nested about the same height. Internest distance was measured for six species. Great Egrets maintained the greatest internest distance whereas Wood Storks and White Ibises had the most closely clumped nests. This may be a defense against avian egg predators.

In most instances, clutch size for all species agreed with most published reports. Clutch size of Great Egrets increased with increasing latitude; this trend was not evident for Snowy Egrets and Louisiana Herons. Mean clutch sizes for Great Egrets, Snowy Egrets, and Louisiana Herons became significantly smaller before the summer solstice. This does not support the proposal that increased daylight hours at higher latitudes during the breeding season is principally responsible for larger mean clutch size. Double-crested Cormorants had a lengthy egg-laying period but there was no decrease or increase in clutch size.

Egg measurements for seven species were similar to published reports except for finding a small egg in a Great Blue Heron nest and one in a Wood Stork nest.

Egg mortality was lower at Moore Creek than for the same species nesting in other rookeries. Greatest egg loss was from unsuccessful nests in which no young hatched. Egg loss for nine species ranged from 8.9% (Snowy Egrets) to 59.2% (Glossy Ibis). The cause of egg loss was not known in most cases. Avian predation was an important egg mortality factor for Wood Storks but to a lesser degree for White Ibises, and rarely evident for other species. High Glossy Ibis egg losses correlate with declining numbers of Glossy Ibis in central Florida. In nesting attempts successful in hatching young a few eggs were lost during incubation, some eggs failed to hatch, and the greatest egg loss was from unknown mortality associated with hatching. Egg mortality in nests hatching young ranged from 5.7% (Louisiana Heron) to 25.5% (Wood Stork).

In many cases, nestling mortality was lower at Moore Creek than for the same species breeding in other rookeries. Double-crested Cormorant nestling mortality at six weeks was 61.7%. Great Blue Heron nestling mortality until fledging was 59.9%. Nestling mortality through four weeks was 23.7% for Anhingas, 37.9% for Great Egrets, and 25.5% for Wood Storks. At two weeks, mortality of young was 15.8% for Snowy Egrets, 28.2% for Louisiana Herons, 42.1% for Glossy Ibises, and 40.2% for White Ibises. Usually, the smallest of the brood died first which was probably due to starvation.

Clutch size was compared to brood success for Double-crested Cormorants, Great Egrets, Snowy Egrets, Louisiana Herons, and White Ibises. Double-crested Cormorant clutches of two resulted in the smallest brood size at six weeks, however clutches of three and four produced virtually equal broods. Great Egret clutches of three produced about the same brood size at four weeks as clutches of two did for the same period of time. If asynchronous hatching is a mechanism for allowing the greatest number of young produced in years of food abundance, Double-crested Cormorants and Great Egrets did not find food abundant. Yet, Snowy Egrets, Louisiana Herons, and White Ibises produced larger broods at two weeks from larger clutches; evidently they had an abundant food supply.

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